Light scattering and absorption studies with single trapped particles

Jonathan P. Reid[a,*], Rose E. Willoughby[a], Antonio Valenzuela[a], Bryan R. Bzdek[a], Hongze Lin[b], and Andrew J. Orr-Ewing[a]

[a]*School of Chemistry, University of Bristol, BS8 1TS, UK*
[b]*Department of Optical Engineering, Zhejiang University, Hangzhou 310058, China*

[*]*Presenting author (j.p.reid@bristol.ac.uk)*

Aerosol particles scatter and absorb light, directly influencing the radiative balance of the atmosphere and climate. The optical cross-section depends on particle size, composition (refractive index) and morphology, and varies with the wavelength of incident light. In addition, the optical cross-section changes in response to environmental conditions (e.g. relative humidity), heterogeneous chemistry (e.g. the formation of light absorbing brown carbon components), and mixing state (e.g. internal and external mixtures). We will present a method for the accurate determination of the optical extinction cross-sections of an individual particle at multiple wavelengths and the dependence on environmental conditions, with continuous monitoring of the optical properties of the same particle over an indefinite timeframe. Such measurements provide accurate data for benchmarking and refining predictive models.

Cavity ringdown spectroscopy (CRDS) has become a widely used technique for interrogating the optical properties of ensembles of aerosol particles, both in field measurements and in laboratory studies. Uncertainties of ±2% are typical in the determination of the real part of the refractive index and larger for the imaginary part. We will discuss the advantages of coupling CRDS with a single particle trap formed from a Bessel beam for studying the optical properties of accumulation mode aerosol. The refractive index can be retrieved at three wavelengths simultaneously with an accuracy of better than ±0.1%. In addition, we will discuss the application of this approach to measurements of the complex refractive index of absorbing aerosol. By the introduction of a modulated heating laser beam in the near-IR, we will show that the temporal-dependence of the change in droplet size can be used to retrieve the imaginary part of the refractive index of solution aerosol with high accuracy at the wavelength of the heating beam.